2016 Addendum

Operations, Maintenance, and Monitoring Plan

Wyckoff/Eagle Harbor Superfund Site

East Harbor Operable Unit

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Region 10

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1. Introduction

This document presents the revised Operations, Maintenance, and Monitoring Plan (OMMP) for the Wyckoff/Eagle Harbor Superfund Site, East Harbor Operable Unit (EHOU) located on Bainbridge Island, Washington (Figure 1). This OMMP is intended to provide the information necessary to guide and develop future monitoring plans, which, when executed, will provide information to the U.S. Environmental Protection Agency (EPA) that supports the next Five-Year Review due in 2017, as well as data to support an Operational and Functional Determination.

This document is referred to throughout the plan as the 2016 OMMP Addendum. The East Harbor OU OMMP was first developed in 1995 (EPA, 1995) to support overall site management. The 1995 OMMP was implemented after completion of the first phases of remediation of the site (1994-1995), and was intended to guide monitoring related to remedy effectiveness, and to provide additional information regarding potential additional remedial requirements. Implicitly recognized in the 1995 OMMP was that as site conditions warranted and/or further remedial actions were implemented, the OMMP would be amended to account for necessary changes in operations, monitoring, and management practices. To date, the updates to the 1995 OMMP have included:

- 1999 OMMP Addendum (USEPA & USACE, 1999) which detailed the additional monitoring objectives and procedures for Year 5 monitoring.
- 2002 OMMP Addendum (USEPA & USACE, 2002) which described changes to the long-term monitoring (LTM) program based upon post-1995 remedial activities at the site.
- 2011 OMMP Addendum (USEPA & USACE, 2011).

This is the fourth addendum to the 1995 OMMP. In addition, previous intensive monitoring efforts covered under the 1995 OMMP have demonstrated that the majority of the 1994 sediment cap has been proven to be functioning as intended and no longer merits the intensive monitoring outlined in the 1995 OMMP.

Monitoring studies conducted from 1994-2002 indicate that the 21.4 hectare sediment cap was largely functioning as intended by isolating underlying contaminated sediments and providing suitable habitat for benthic organisms. Since 2002, additional remediation occurred in areas (West Beach) where polycyclic aromatic hydrocarbon (PAH) concentrations were found to be elevated relative to the Washington State Sediment Management Standards Sediment Quality Standard (SQS) or Minimum Cleanup Levels (MCUL). In other areas (East Beach) the progress of monitored natural recovery continues to be tracked, with a goal of achieving PAH levels below the MCUL within the 10-year timeframe set in the 1994 Record of Decision (ROD).

Physical monitoring results from the 2011 event showed substantial loss of the subtidal cap located within the ferry navigation lanes. Additional physical surveys were undertaken by the Washington State Department of Natural Resources (DNR) to aid in planning for cap repair in the Phase I scour areas and to support EPA's planned site maintenance activities in the area offshore of the former facility's West Dock (Figure 2). The latter area, referred to as grids J9/J10, is on the margins of sequential past capping efforts. These data are collectively being used by EPA to inform the need for and extent of cap repairs.

The 2016 OMMP Addendum focuses monitoring activities on areas remediated since the 2002 monitoring event, and provides continuing support to the findings that areas remediated since 1994 are functioning as designed to prevent exposure. A summary of previous site activities is provided in Section 1.1.

This document presents the current state of knowledge, rationale for changes to the 1995, 1999, 2002, and 2011 OMMP objectives, and specific monitoring methods necessary to document progress toward, attainment of, and continued compliance with the cleanup goals and objectives as stated in the 1994 ROD. The 2016 OMMP Addendum supersedes the 1999, 2002 and 2011 OMMP Addenda and the 1995 OMMP; however portions of those plans detailing sampling methodologies are carried forward by reference.

1.1. Site History and Recent Site Activities

1.1.1. Site Chronology

A brief chronology of site events and activities that are pertinent to the East Harbor OU, the 1995 OMMP, and development of the 1999, 2002, and 2011 OMMP Addenda is provided below. The chronology is adapted from EPA's 2012 Five-Year Review document (EPA, 2012) and previous site investigations (i.e., On-Scene Coordinators Report, Fact Sheets, monitoring investigations).

Event	Date
The Wyckoff/Eagle Harbor site was added to the National Priority List	1987
Completion of the Remedial Investigation	1989
Completion of the Feasibility Study for Eagle Harbor	1991
Removal Action – Placement of sand cap over 21.4 hectares of contaminated sediments	1993-1994
Construction monitoring of removal action	1993-1994
EPA completed ROD for the East Harbor OU, which included the following elements: (1) monitor and maintain the existing sediment cap, additional capping in remaining subtidal areas of concern; (2) monitor success of natural recovery in intertidal areas; (3) enhance existing institutional controls to reduce public exposure to contaminated fish and shellfish; (4) demolish in-water structures	1994
Baseline, Year 0 monitoring of subtidal cap	1994
Year 1 monitoring of subtidal cap	1995
Year 3 monitoring of subtidal cap	1997
Removal of in-water structures (e.g., piers and pilings)	1996-1999
1999 OMMP Addendum	1999
Year 5 monitoring of subtidal cap	1999
Installation of sheet pile wall around upland site	1999-2001
Intertidal investigation around the Wyckoff facility	1999-2002
Placement of Phase II subtidal cap	2000-2001
Placement of Phase III subtidal nearshore and intertidal cap	2001-2002
EPA created habitat Mitigation Beach at West Beach and placed Phase III subtidal nearshore and intertidal cap.	2001-2002
2002 OMMP Addendum	2002
Year 8 monitoring of subtidal cap, intertidal cap, Mitigation Beach, and East Beach natural recovery	2002
First Five-Year Review	2002

Event	Date
Surface sediment samples in the visibly-contaminated areas of the West Beach Mitigation Beach	2005
West Beach intertidal sediment investigations	2005-2006
Second Five-Year Review	2007
Explanation of Significant Differences (ESD) for the West Beach Exposure Barrier System (EBS)	2007
Construction of the West Beach EBS	2007-2008
2011 OMMP Addendum	2011
Year 17 monitoring of subtidal cap, intertidal cap, EBS, East Beach, and North Shoal natural recovery	2011
Additional East Beach and North Shoal investigations	2012
Third Five-Year Review	2012
Additional subtidal cap investigations (DNR-directed)	2014
Clam tissue collection and analysis	2014
Proposed Plan for East Harbor and Upland OUs completed	2016
2016 OMMP Addendum	2016

1.1.2. Recent Site Activities

Relevant completed remedial actions in EHOU include:

- Placement of subtidal sediment cap completed in three phases between 1993 and 2002.
- Upland source control completed in February 2001 by installation of a sheet pile wall around the perimeter of the former process area.
- Construction of a Mitigation Beach (completed in 2002) including removal of 366 linear meters (m) [1,200 linear feet (ft)] of bulkhead, excavation of approximately 40,000 cubic yards (cy) of upland sediments, and placement of 8,500 cy of clean imported sand – creating approximately 0.8 hectares (2 acres) of intertidal beach habitat.
- Construction of the Exposure Barrier System (EBS) which consists of two primary elements: a beach cover system placed on top of the existing beach sediments and previously placed habitat fill in the intertidal zone (Mitigation Beach), and an extension of the existing subtidal cap from the previous southern edge to overlap with the beach cover system.

Figure 1 shows the location of all three phases of the subtidal cap and the EBS. Figure 2 shows the intertidal areas of EHOU which include West Beach (consisting of the EBS and riparian habitat); the Intertidal Cap; the North Shoal area; and the East Beach area. Figure 2 also shows the area of the former facility West Dock.

The most recent long-term monitoring event for the EHOU was completed in 2011 (USEPA & USACE, 2012). Those data and report served to inform EPA's 2012 Five-Year Review. The upcoming 2016 Year 22 monitoring event will provide information needed to inform the next Five-Year Review, which is due in 2017.

Only specific subtidal and intertidal areas of the EHOU will be monitored under this 2016 OMMP. Of the constructed intertidal and subtidal remedies, only the EBS will be monitored to confirm that the

implemented remedial action is functioning as designed (1994 ROD, 2007 ESD, 1995 OMMP, 1999 OMMP Addendum, 2002 OMMP Addendum, and 2011 OMMP Addendum). Cap maintenance, as well as additional remedial construction, are planned or under consideration for the Phase I and II capping areas, in the area of the former facility West Dock (potentially impacting the Phase III Cap and North Shoal), along the North Shoal, and at East Beach. A proposed plan was issued in 2016 for public comment proposing to amend the remedial action in the 1994 ROD. Long term monitoring for these areas is deferred until after completion of the planned/proposed construction.

Additional sampling within the North Shoal subtidal area is also included in the 2016 monitoring to provide information for remedial planning.

1.2. Rationale for Monitoring

A brief description of the salient monitoring elements and the tools that will be used to address those in the 2016 OMMP Addendum are presented below. The technical rationale for each monitoring technology, its goals within the 2016 OMMP Addendum, and the areas of the EHOU where the monitoring technology will be applied are discussed in detail in Sections 2 and 3.

1.2.1. Physical Stability Monitoring

Physical stability measures will be used to compare current conditions at the EBS to post-construction conditions, support an evaluation of whether additional actions are needed if differences are significant, and to support the conceptual site model (CSM). Physical stability measures for the 2016 OMMP Addendum include the following:

Bathymetry. Hydrographic surveys will be used to measure the subtidal elevations across the EBS. The hydrographic survey will cover the entire area of the EBS beginning north of the cap boundary in approximately -20 ft mean low low water (MLLW), and run inshore to the highest practicable tide allowed (to a minimum of +2 MLLW). The methods and goals of the bathymetric surveying are changed from the 2011 survey. The previous surveys were completed with single-beam sonar; the 2016 survey will be completed with multi-beam sonar.

Beach Elevation Surveys. Beach elevation surveys are a monitoring element first introduced in the 2002 OMMP Addendum. These surveys confirm the physical stability of intertidal remedial construction efforts and support the CSM particularly in the area of the EBS (including west of West Beach to track habitat mix movement). Consistent with the 2011 survey, photogrammetric survey methods will be used and the resultant elevation maps will be compared to both the 2011 results and the 2008 post-construction survey to determine areas erosion and/or accretion on the EBS.

Habitat Mix and Sand Cap Direct Measurements. Direct field measurement of the physical presence (thickness) of habitat mix will occur on West Beach to confirm the presence of the EBS sandy habitat mix cover. On West Beach, in the area of the EBS, the thickness of any cap material will be measured using a measured stake. The results may inform the placement of two discretionary West Beach sediment cores (see Section 3.3.4).

1.2.2. Chemical Isolation Monitoring

Sediment surface and subsurface samples, chemically tested for PAHs, are used to confirm that the sediment cap remedy is isolating the chemicals of concern. Measures used to ensure chemical isolation in the 2016 OMMP Addendum include the following:

Subtidal Cap Surface Sediment Collection. Surface sediment grab samples (0-10 cm) will be collected from grid J9 and J10, where cap material did not meet the target cap thickness[1]. These are discussed in more detail in Section 2. The methodology to be employed remains unchanged from the 1995 OMMP, 1999 Addendum, and 2002 OMMP Addendum (The 2011 OMMP Addendum included discrete grab samples for J9 and J10; this will not be implemented in the 2016 OMMP Addendum. Three discrete grab samples will be collected at both J9 and J10; the three grab samples will be composited into a single sample for chemical analyses. Additional sediment from each collected discrete grab sample will be archived for potential later analyses. This compositing scheme is consistent with the methods employed in the 2002 OMMP Addendum).

1.2.3. Natural Recovery Monitoring

Natural recovery is the identified remedial alternative for the North Shoal and East Beach. No natural recovery monitoring will be conducted in the 2016 OMMP Addendum. A proposed plan for a new remedial action in the North Shoal and East Beach areas was issued in 2016.

1.2.4. Biological Monitoring

Biological monitoring is conducted to help address whether the remedies provide functioning habitat, and where shellfish occur, to determine if those shellfish are safe for human consumption. The 2011 OMMP Addendum included a forage fish habitat use survey, which will not be performed as part of the 2016 OMMP Addendum. Biological monitoring measures for the 2016 OMMP Addendum do include the following:

Clam Tissue Collection. The collection of clam tissue samples from East Beach and North Shoal sediments was first included in the 2002 OMMP Addendum. The 2011 OMMP Addendum also included clam tissue (*Tresus capax*) sampling from the Intertidal Cap and West Beach, including the EBS. An additional collection of horse clam (*T. capax)* tissue occurred in 2014 from locations within the Intertidal Cap, North Shoal, West Beach, and East Beach locations (USACE 2015). The 2016 field effort will include all four of these areas plus a background location identified by the Suquamish Tribe within their Usual and Accustomed fishing areas. The purpose of the collection and analysis of clam tissues is to assess the extent of natural recovery since the 2011 monitoring event and to provide additional human health risk information.

1.2.5. Additional Sediment Monitoring

Subtidal North Shoal Sediment Collection. Subtidal surface sediment samples will be collected from the top 10 cm at these locations, as well as subsurface sediment cores (6-feet length).

West Beach Surface Sediment Collection. Intertidal surface/subsurface sediment cores will be collected from West Beach and the area west of West Beach (east of the marina). Cores will be 0-2 ft depth, or to the depth of the cobble (whichever is shallower). These are discussed in more detail in Section 3.3.4.

[1] Grids J9 and J10 include the former West Dock area, which is being considered by EPA for additional remediation (see Figure 2). The samples from these grids were included in the 2011 OMMP as subtidal cap samples, and are thus included here.

2. Area and Monitoring Objectives

This 2016 OMMP Addendum is intended to update the overall monitoring plan for the EHOU. The Work Plan will guide the collection of information necessary to support the site's Five-Year Review in 2017. This 2016 OMMP Addendum includes updates to the monitoring objectives defined in the 2011 OMMP Addendum and provides for additional monitoring to cover actions completed since the last Five-Year Review in 2012.

This 2016 OMMP Addendum describes the rationale for each task of the post-remedial action monitoring in accordance with the ROD (USEPA, 1994) and the 2007 ESD (USEPA, 2007) for the West Beach EBS. The 2016 monitoring represents the sixth monitoring event to occur since the 1994 Removal Action. This is considered to be the Year 22 monitoring event and monitoring objectives address concerns specific to this event while also retaining relevant objectives from previous events. This plan may be modified for future events based on monitoring results. At this time, monitoring events and methods described within are appropriate and necessary to meet ROD objectives. Table 1 presents the 1994 ROD and 2007 ESD Sediment Standards Chemical Criteria.

Table 1. Sediment Standards Chemical Criteria

Chemical of Concern	**SQS (mg/kg organic carbon, dry weight)**	**MCUL (mg/kg organic carbon, dry weight)**	**MTCA Method B Soil CUL[1] (mg/kg, bulk weight)**	**Preliminary Sediment Remediation Goals[2] (µg/kg, dry weight)**
Mercury	0.41 mg/kg (dry weight)	0.59 mg/kg (dry weight)	NA	--
LPAHs	370	780	--	--
Naphthalene	99	170	3,200	--
Acenaphthylene	66	66	--	--
Acenaphthene	16	57	4,800	--
Fluorene	23	79	3,200	--
Phenanthrene	100	480	--	--
Anthracene	220	1,200	24,000	--
2-Methylnaphthalene	38	64	320	--
HPAHs	960	5,300	--	--
Fluoranthene	160	1,200	200	--
Pyrene	1,000	1,400	2,400	--
Benz[*a*]anthracene	110	270	0.14	631
Chrysene	110	460	0.14	63,038
Benzo[*b*]fluoranthene	--	--	0.14	631
Benzo[*k*]fluoranthene	--	--	0.14	6,308
Total Benzofluoranthenes	230	450	--	--
Benzo[*a*]pyrene	99	210	0.14	63
Indeno[1,2,3-*cd*]pyrene	34	88	0.14	631
Dibenz[*a,h*]anthracene	12	33	0.14	63
Benzo[*g,h,i*]perylene	31	78	--	--
Pentachlorophenol	--	--	8.3	--
cPAHs (sum TEQ)	--	--	--	63

MCUL – minimum cleanup level
SQS – sediment quality standard
TEQ – toxicity equivalency quotient
1 – MTCA Method B soil cleanup levels were selected in the 2007 ESD to be protective of human health.
2 – EPA selected sediment remediation goals in the 2016 Proposed Plan for the East Harbor and Uplands OUs. Final remediation goals will not be determined until the ROD Amendment is issued.

2.1. Subtidal Monitoring Objectives

The 1999 OMMP Addendum originally defined the monitoring required for the subtidal cap; focusing on collecting data required to answer the following questions:

1) Is the cap physically stable, remaining in place at a desired thickness?

2) Is the cap effectively isolating the underlying contaminated sediments?

3) Are sediments in the biologically active zone (0-10 cm) remaining clean relative to the Washington State Sediment Management Standards (SMS)?

The 2011 monitoring event evaluated the Phase I, Phase II, and Phase III caps. The 2016 monitoring event will focus on specific areas identified in the 2011 monitoring event and the 2012 Five-Year Review for additional investigation. The results of the 2011 monitoring event demonstrated that the entire sediment cap, with the exception of two areas, is performing as intended; the caps are remaining stable, have achieved chemical isolation, and have remained clean relative to the SMS.

The first area where the cap is not performing as intended, is the Phase I cap beneath the Washington State Ferries navigation lane, where ferries transit the site. In this area, no capping material remained and surface sediment concentrations exceeded the SMS. The second area is the vicinity of grids J9 and J10.

J10 was within the Phase II capping boundaries. Phase II cap material was observed in the cores collected in 2011, and generally met target depths. All three J10 surface samples concentrations were below the SQS. One J10 core had subsurface sediment concentrations that exceeded SMS. Grid J9 is outside both the Phase I and Phase II capping areas (see Figure 2). Here coring presented a more complicated picture. At J9, three of four coring locations had no cap material present. At the single location (J9a in the 2011 report) the cap material present was Phase II material. While all three J9 surface sample concentrations met the SQS, non-aqueous phase liquid (NAPL) was observed in subsurface sediment cores only 1-2 feet below mud line (bml). Cap material was present at J10 and generally met target depths, and all three J10 surface sample concentrations met SQS. One J10 core had subsurface sediment concentrations that exceeded SMS.

In 2014, videocoring/coring work was performed to refine the areas within the ferry navigation lane that will need additional material and to help define the J9 areas where cap material is not present (Integral 2014). The results of this work was used to scope the ferry navigation lane cap repair work that is scheduled to begin in January 2017.

The following sections discuss how the findings of previous monitoring events for physical stability, chemical isolation, and performance relative to the SMS affect the planned monitoring.

2.1.1. Physical Stability

The 2011 monitoring results demonstrate that the majority of the subtidal sediment cap is performing as intended using a bathymetry survey and cap thickness measurements determined from through-cap coring. Physical stability using bathymetry and through-cap coring for the subtidal caps will not be performed in the 2016 monitoring. The Phase I cap beneath the ferry navigation lane will be repaired with construction anticipated to begin in 2017.

2.1.2. Chemical Isolation

The objective for the subtidal cap is to ensure that the cap still meets the cleanup goals as defined in the ROD, and specifically to evaluate the chemical isolation in surface and subsurface capped sediments, relative to the SMS. Chemical isolation is evaluated based upon results from the subtidal through-cap

cores relative to the SMS. Results from surface sediment characterization are also used in this evaluation; surface characterization is discussed below in response to monitoring question #3.

The 2011 monitoring results demonstrate that the majority of the sediment cap is performing as intended, with the exceptions mentioned above. Through-cap coring will not be performed in the 2016 monitoring.

2.1.3. Subtidal Surface Sediments Relative to the SMS

Monitoring question #3 is evaluated based on the comparison of surface sediment composite samples collected within each grid, and comparing the results to the criteria listed in Table 1.

The J9 and J10 areas will be resampled by collecting three surface grab samples within each grid, for one composite analysis. An individual archived sediment sample will be collected for each discrete grab sample location.

2.2. Intertidal Monitoring Objectives

Four adjacent intertidal areas are defined around the perimeter of the Wyckoff site as shown in Figure 2. The areas are artificially separated for monitoring purposes but represent continuous intertidal habitat surrounding the site. The areas are described here in an east to west direction:

- East Beach is located to the east of the Wyckoff facility and faces Puget Sound. It contains active contaminant seeps and was identified for monitored natural recovery in the ROD.
- The North Shoal is located north of the Wyckoff facility and faces Eagle Harbor.
- The Intertidal Cap was created during the capping of highly contaminated subtidal sediments in the former log-rafting area.
- The EBS, located in the intertidal area west of the Intertidal Cap, is part of West Beach together with the riparian habitat created in 2001-2002.

The monitoring objectives for the intertidal areas are described below.

2.2.1. Physical Stability

Physical stability of the entire intertidal area has been monitored primarily with hydrographic and topographical surveys. For West Beach (i.e., the EBS), hydrographic and aerial surveys will be conducted, as well as direct habitat mix depth measurements. The area west of West Beach will also be included in these physical surveys (Figure 3). East Beach, North Shoal, and the Intertidal Cap will not be surveyed in the 2016 monitoring event. A proposed plan proposing a change in the remedy for the East Beach and North Shoal was issued in 2016 and a ROD Amendment describing a new remedy is anticipated to be issued in 2017.

2.2.2. East Beach

The overall purpose of the East Beach monitoring is to determine:

- if contaminant concentrations decrease over time and if so, evaluate the rate of natural recovery;
- if the East Beach area has naturally recovered within the 10-year time frame stated in the 1994 ROD; and,
- the stability of the beach over time.

No visual survey or sampling of sediment will occur in the 2016 monitoring event. As mentioned above, a proposed plan was issued in 2016 proposing to change the remedy for the East Beach. A ROD describing a new remedy is anticipated to be issued in 2017.

The 2002 and 2011 OMMP Addendums included the collection of horse clam (*T. capax*) and native little necks (*Protothaca staminea*) for residual chemical tissue analysis to evaluate the progress of natural recovery, and whether there are human health risks from consuming clams collected at East Beach. An additional survey was conducted in 2014 (USACE 2015). The 2016 monitoring event will follow the same methodology as the 2011 and 2014 events, and collect only horse clam (*T. capax*) tissue because of their relative abundance at the site. In addition horse clams will be collected from a background location. No visual surveys of bird, mammal, and invertebrate use of the East Beach will be conducted in the 2016 monitoring event.

2.2.3. North Shoal Intertidal Area

No monitoring for elevation changes, visual seeps, and changes to surface sediment chemical concentrations will occur in the 2016 monitoring event. As mentioned above, a new remedy for North Shoal is anticipated to be issued in a final ROD in 2017.

The 2011 monitoring event collected horse clams (*T. capax*) to address whether consumption of clams present a human health risk. The 2016 monitoring event will follow the same methodology as the 2011 and 2014 monitoring events. No visual surveys of bird, mammal, and invertebrate use of the North Shoal will be conducted in the 2016 monitoring event.

2.2.4. Intertidal Cap

The 2011 monitoring event collected horse clams (*T. capax*) to address whether consumption of clams present a human health risk. The 2016 monitoring event will follow the same methodology as the 2011 and 2014 monitoring events. No visual surveys of bird, mammal, and invertebrate use of the Intertidal Cap will be conducted in the 2016 monitoring event.

2.2.5. West Beach and the Exposure Barrier System

West Beach and EBS monitoring will include chemical isolation monitoring and a physical stability analysis. Chemical isolation monitoring will include surface/subsurface sediment cores in the West Beach/EBS area and west of West Beach. Samples are intended to represent potential exposures to beachgoers. Samples will be located and analyzed to determine contaminant concentrations as described in Section 3.3.4.

Physical stability monitoring will include hydrographic and topographic surveys of the EBS and west of West Beach (east of the marina), and direct measurements of the habitat layer and sand cap thickness in the EBS (described in Section 3.3.4). Results of the habitat layer measurements will be used to assess erosion and accretion in the habitat layer. Results may also be used to inform the placement of the two discretionary beach sediment cores.

The 2011 monitoring event collected horse clams (*T. capax*) to address whether consumption of clams present a human health risk. The 2016 monitoring event will follow the same methodology as the 2011 and 2014 monitoring. No visual surveys of bird, mammal, and invertebrate use of the EBS and West Beach will be conducted in the 2016 monitoring event.

2.3. Additional Monitoring Objectives

The subtidal areas of the North Shoal east of the Phase I cap have not been previously characterized. Surface samples and subsurface cores will be collected in the areas of J7, J8, K7, K8, and L8 (Figure 3) in order to characterize this area. Three surface grab samples per grid area will be collected, which will be composited for analysis. For each surface grab sample collected, a single archived sediment sample will

be retained (a total of 15 archived grab samples). One subsurface sediment core (6 ft length) per grid area will be collected to determine the presence or absence of NAPL, sandy cap material, other debris (e.g. woody debris, shells).

Table 2. Area and Monitoring Objectives

Objectives		Area Objective	Monitoring Objective	Associated Field and Analytical Actions	Evaluation Process and Criteria
O&F	**Five-Year Review**				
Cap (J9, J10)					
X	X	Determine if the cap meets cleanup goals as defined in the ROD.	Evaluate chemical isolation in surface capped sediments.	**Surface Sediment Samples.** Surface sediment (0-10 cm) samples from grids J9 and J10. Three grab samples from each grid will be collected and composited into one analysis for PAHs, pentachlorophenol (PCP), mercury, TOC, and grain size.	Compare results to Washington Management Quality Standards (SMS) Minimum Cleanup Level (MCUL) or second Lowest Apparent Effects Threshold (2LAET).
North Shoal Subtidal Area (Grid Cells J7, J8, K7, K8, L8)					
	X	Characterization of the subtidal area of the North Shoal.	Evaluate chemical concentrations in subtidal surface sediments to determine the presence or absence of NAPL in subsurface sediments.	**Surface Sediment Samples.** Surface sediment (0-10 cm) samples from grid cells J7, J8, K7, K8, and L8. Three grab samples per grid will be collected, composited, and analyzed for PAHs, PCP, mercury, TOC, and grain size (i.e. one analysis per grid cell). For each grab sample a separate archived sediment sample will be collected and retained. **Subsurface Sediment Cores.** A single subsurface sediment core (6-feet length) will be collected from grid cells J7, J8, K7, K8, and L8. Cores will be evaluated for the presence or absence of NAPL, sandy cap material, and other debris (e.g. wood, shells, etc.).	Compare results of surface samples to Washington Management Quality Standards (SMS) Minimum Cleanup Level (MCUL) or second Lowest Apparent Effects Threshold (2LAET). Visually evaluate subsurface cores for the presence or absence of NAPL, sandy cap material, and debris.
Intertidal Areas					
	X	Assess contaminant concentrations in surface sediments to evaluate human exposures.	Evaluate chemical concentrations in sediments around the former pier location.	**West Beach Surface/Subsurface Cores.** Surface/subsurface sediment cores (2-ft length) from the West Beach (includes the EBS and the area west of West Beach). Four sample stations based on the OMMP grid system were selected (Figure 4), plus two discretionary core locations (to be field determined, see next row). Three cores per sampling location will be collected, then composited into a single sample for analysis. Samples will be analyzed for PAHs, PCP, TOC, and grain size.	Compare results to SQS and MTCA B.
X	X	Assess the effectiveness of placed cap at the EBS in isolating contaminants.	Evaluate physical stability of the West Beach and the EBS.	**West Beach Land-based Topographic Survey.** Topographic surveys (hydrographic and photogrammetry) will be conducted in the West Beach area (EBS and west of West Beach). **EBS Habitat Mix and Sand Cap Direct Measurement.** Measure the thickness of the EBS in eighteen locations.	Assess physical stability and trends at West Beach and the EBS. Originally in the intertidal, two feet of habitat material was placed over one foot of cobble at the EBS. If there is evidence of physical instability (less than two feet of habitat mix remains) or the presence of NAPL is observed, then up to two discretionary cores composites (three 2-foot surface/subsurface cores composited, as above row) shall be collected in areas of instability or NAPL.
X	X	Determine if intertidal areas provide functioning habitat.	Evaluate whether the placed remedies provide functioning habitat – natural recovery, and whether shellfish are safe for human consumption.	**Clam Tissue Samples.** USACE will collect clam samples from all intertidal areas.[2]	Track trends with previous tissue data and compare clam tissue chemistry results to standards for human health. [The proposed target tissue concentration for cPAHs is 0.12 µg/kg (benzo[*a*]pyrene) TEQ][3].

O&F – operational and functional determination
TEQ – toxicity equivalence

[2] Clam sampling was completed by USACE on July 5-6, 2016, prior to finalization of the 2016 OMMP Addendum.
[3] This is the selected target tissue concentration in the 2016 Proposed Plan for the East Harbor and Uplands OUs. Final target concentrations will not be determined until the ROD Amendment is issued.

3. Monitoring Assessment and Approach

This section identifies the measurement method proposed for each area and monitoring objective. Table 2 presents the area and monitoring objective along with the proposed assessment method.

This section provides a broad overview of the proposed tools and assessment approach. Details of the data collection methods, quality assurance procedures, data management, and interpretive criteria will be provided in the QAPP(s) that will be developed by the contractor. The contractor will also propose analytical methods in the QAPP sufficient to reach appropriate quantitation limits.

3.1. Subtidal Cap Physical Stability

The 2011 monitoring event results showed that the subtidal caps were generally stable with the exception of the Phase I cap beneath the Washington State Ferries navigation lane. A cap repair for this area is anticipated to occur in 2017. The subtidal cap will not be assessed for physical stability in the 2016 monitoring event.

3.2. Subtidal Cap Chemical Effectiveness

The 2011 monitoring event results showed that the subtidal caps had achieved chemical isolation with the exception of the Phase I cap beneath the Washington State Ferries navigation lane and potentially in the area of J9. A cap repair for the navigation lane is anticipated to occur in 2017. Evaluating chemical effectiveness includes surface samples at J9 and J10.

3.2.1. Grid System Sediment Sampling

The grid system established in the 2011 OMMP addendum will be used for the 2016 monitoring event.

3.2.2. Cap Surface Sediments

Subtidal cap surface sediment sampling will occur at grid locations J9 and J10 (see Figure 3). The rationale for the designation of this specific station is presented in Section 2.1.3. Three surface sediment grab samples (0-10 cm) will be collected, composited into one analysis, and analyzed for PAHs, PCP, mercury, TOC, and grain size. The QAPP will identify the how the three grab sample locations will be determined from within each grid section.

3.3. Intertidal Monitoring

3.3.1. East Beach

East Beach monitoring will include clam tissue samples only. No sediment samples will be collected as mentioned in Section 2.2.2. Clam tissue collection and analysis will focus on horse clams (*T. capax*), consistent with species collected in the 2011 and 2014 monitoring events. A separate QAPP that is specific to clam tissue collections will be prepared. This separate work plan is necessary in order to have the needed documentation in place for clam sampling, which will occur in early July 2016[4]. Once finalized, that QAPP will be adopted as part of the site-wide QAPP.

[4] The intertidal clam sampling was completed by USACE on July 5-6, 2016, prior to finalization of the 2016 OMMP Addendum.

Clams will be collected from the locations previously sampled in 2011and 2014. Sufficient tissue will be collected to analyze PAH and lipid content and will follow methods previously used at EHOU modified using the more recent methods described by Washington Department of Health. The collection of clams will be dependent on the presence of clams within the intertidal sediments. If a targeted location does not have clams, the collection area may be enlarged in order to collect sufficient clams for analysis. Clams submitted for analysis will be sized and enumerated to assist in evaluation of age-related (size) perturbations in body burdens. To the extent possible, clams larger than 4 inches will be submitted for analysis.

3.3.2. North Shoal

The North Shoal monitoring will include clam tissue samples only. No sediment samples will be collected as mentioned in Section 2.2.3. Clam tissue collection and analysis will be the same as that for the East Beach. The data will be used to address whether natural recovery is occurring and to evaluate whether consumption of clams presents a human health risk.

3.3.3. Intertidal Cap

The Intertidal Cap monitoring will include clam tissue samples only. No sediment samples will be collected as mentioned in Section 2.2.4. Clam tissue collection and analysis will be the same as that for the East Beach. The data will be used to address whether natural recovery is occurring and to evaluate whether consumption of clams presents a human health risk.

3.3.4. West Beach and the Exposure Barrier System

Surface/subsurface sediment cores will be collected on the West Beach to assess chemical isolation of the EBS and to determine whether concentrations on the surface impact recreational users of the beach. The entire West Beach will be evaluated to include the EBS and the area west of West Beach (east of the marina). Six sample locations (Figure 4) will be evaluated using the existing grid system; four are pre-determined sites, and two are discretionary sites. The grid locations identified for the EBS were used during the 2011 sampling. The two discretionary core locations will be determined in the field. These locations will be based upon locations where the habitat layer thickness is found to be less than 2 feet, locations with NAPL presence or odor, or will simply be located to provide additional aerial coverage. At each sample location, three individual sediment cores will be collected to a depth of 2 feet, or to the depth of the cobble (whichever is shallower). Presence of NAPL or other visible contamination should be noted for each core. The three individual cores for each sample location will be composited together for one analysis of PAHs, PCP, TOC, and grain size. The QAPP will identify the how the three core locations will be determined for each grid location.

A topographic survey of the EBS and the area west of West Beach (east of the marina) will be conducted to evaluate changes in elevation. In addition, habitat thickness on the EBS will be confirmed by pushing a measuring rod through the fish habitat fill, and recording both the location of the measurement and the length of the rod that passes through the fish habitat fill before contacting the underlying cobble layer. This will be done at twenty locations on West Beach/EBS; locations will be identified in the QAPP. Measurements will be conducted at low tide to properly reach intertidal areas. Confirmation of the intertidal thickness will be done by comparing the results of the topographic survey to the as-built drawings.

Clam tissue collection and analysis will be the same as that for the East Beach. The data will be used to address whether natural recovery is occurring and to evaluate whether consumption of clams presents a human health risk.

3.4. Habitat Use Surveys

No habitat use surveys will be conducted.

3.5. Additional Monitoring

At the former West Dock location (J7, J8, K7, K8, and L8), three subtidal surface sediment samples (0-10 cm) per grid will be collected and composited into one sample analysis. Samples will be analyzed for PAHs, PCP, mercury, TOC, and grain size. The QAPP will identify the how the three grab sample locations will be determined from within each grid section.

In addition, one subsurface sediment core (6-ft length) will be collected from each grid section, and evaluated for the presence/absence of NAPL, sandy cap material, and other debris (wood, shells, etc.).

4. References

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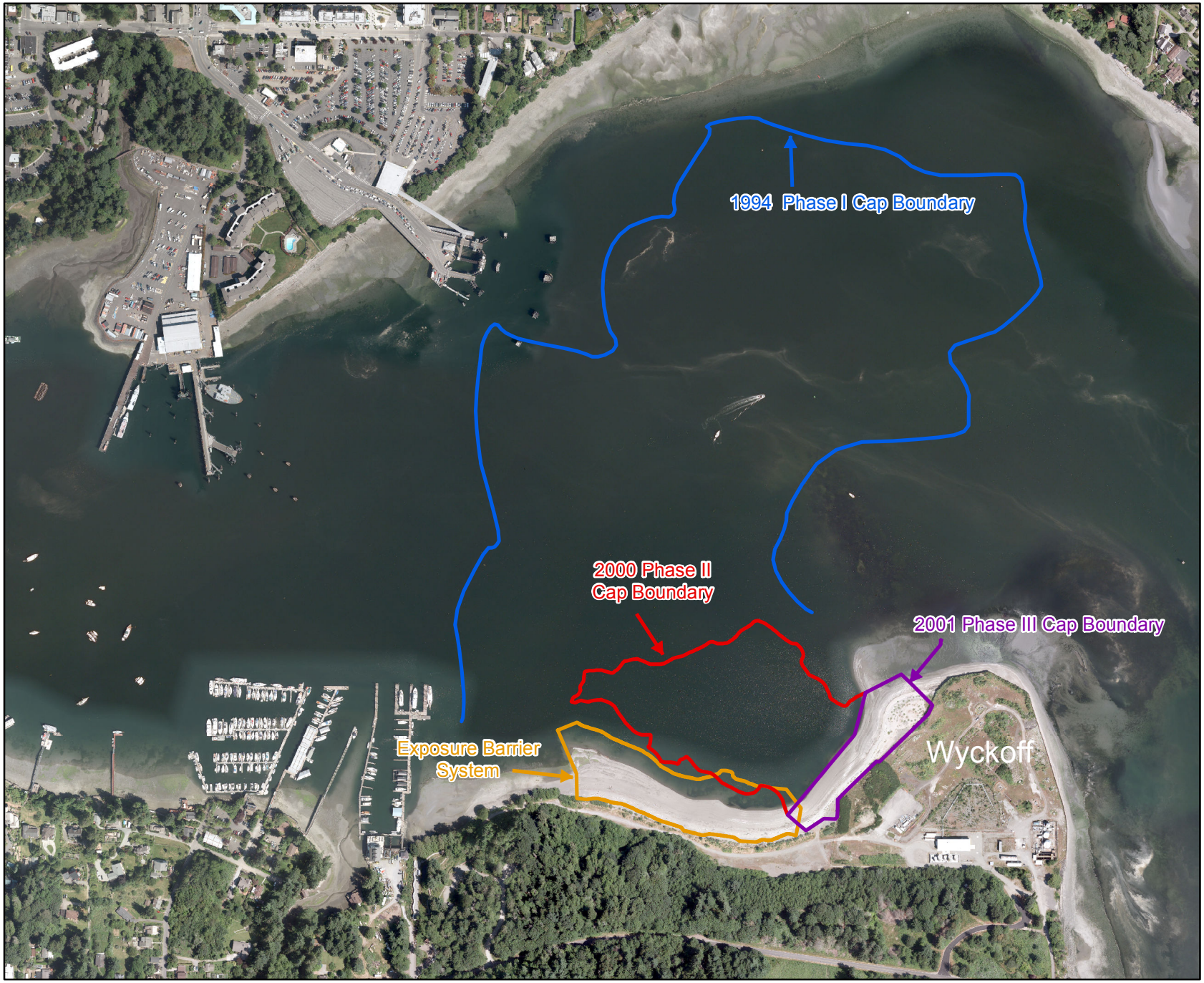
Figure 1. Location of East Harbor OU Cap Areas



Legend

- 1994 Phase I Cap Boundary
- 2000 Phase II Cap Boundary
- 2001 Phase III Cap Boundary
- Exposure Barrier System

Location Map

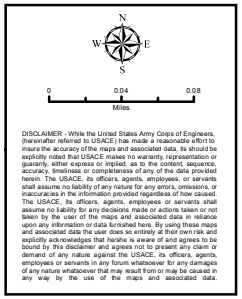


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Figure 2. Intertidal Areas of East Harbor OU

Legend

Exposure Barrier System

Location Map

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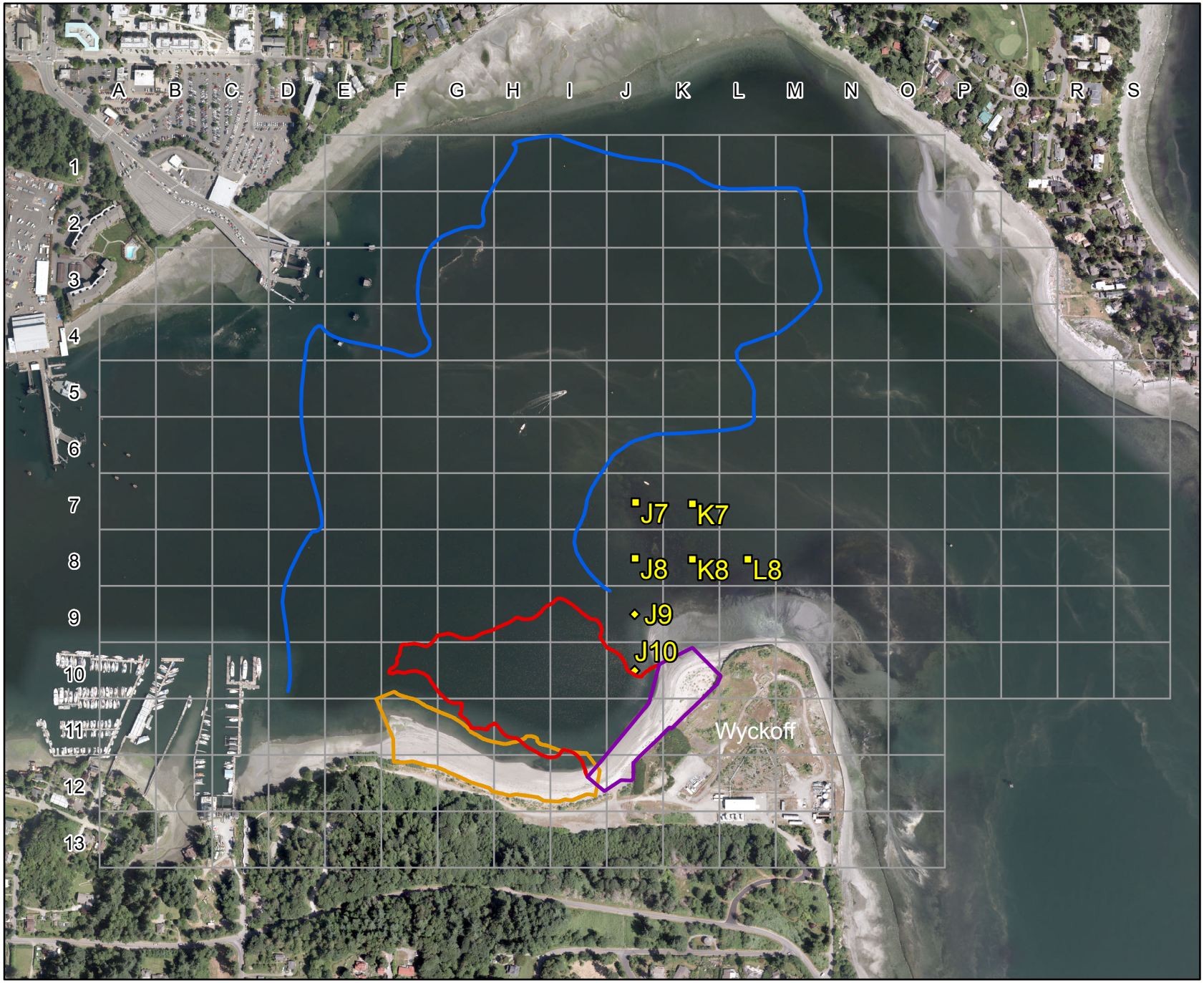
Figure 3. Subtidal Sediment Sample Locations



Legend

- Surface Sample Only
- Surface Samples and Subsurface Cores
- 1994 Phase I Cap Boundary
- 2000 Phase II Cap Boundary
- 2001 Phase III Cap Boundary
- Exposure Barrier System

Location Map

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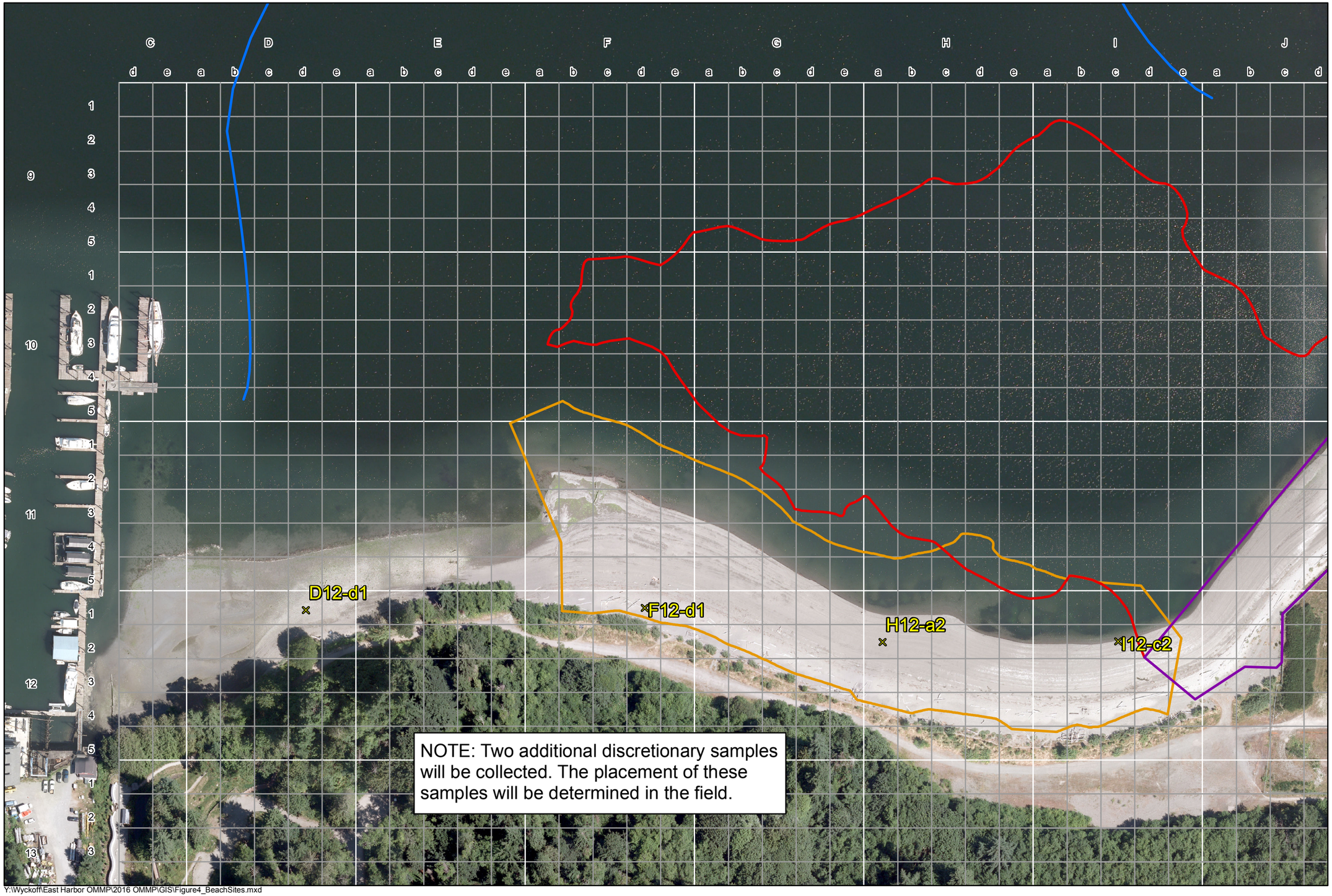
Figure 4. Beach Sediment Sample Locations



Legend

- Beach Sample Locations
- 1994 Phase I Cap Boundary
- 2000 Phase II Cap Boundary
- 2001 Phase III Cap Boundary
- Exposure Barrier System

Location Map

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